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Real-Time GPS Receiver System Implementation for Providing Location Based Services and SMS Tracking

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ABSTRACT
This paper describes the design of a real-time GPS receiver system in a very simple and efficient fashion for navigation, tracking and positioning. This system is designed to provide location based parameters in real time like latitude, longitude, altitude, current location name and altitude. The values of these parameters are displayed on a GUI (Graphical User Interface). The system also provides a website application where the values of the parameters on the GUI are displayed in a tabulated form on the website. The parameter values are continuously updated and are displayed on the GUI. The updated parameter values on the GUI are also added to the table in the website. Hence the table shows the real-time parameter values along with the values which were previously displayed on the GUI. An internet based SMS (Short Message Service) application is also developed which will message the real time latitude, longitude, altitude, speed and location name to the user's mobile. The system consists of an antenna which acquires the satellite signals. These signals are given to the GPS receiver. The receiver is provided with a Universal Serial Bus (USB) connector so that it compatible and can be easily connected to a Personal Computer (PC) or laptop. The system software in the PC or laptop is developed in Visual Basic.NET computer programming language. The system is easy to use and provides real-time results in the form of visual displays.
Keywords - Global Positioning System, Graphical User Interface, Navigation, Positioning, Parameters.

I. Introduction

Navigation is defined as determination of position and velocity of any still or moving entity on land, sea, air or in the space [1]. In navigation the position and its related parameters are required immediately or after certain delay. This is called real time navigation. Hence in order to navigate real time data is required. In navigation the position is not constant. It is variable and is dependent on time. Before the advent of modern technologies there were other methods of navigation like dead reckoning, piloting, and celestial. These navigation systems were dependant on geographic features, landmarks and observation of positions of the sun, moon, planets and navigational stars. Nowadays, navigation primarily relies on positions determined electronically by receivers collecting information from satellites. Aircrafts, missiles, ships, sea vessels, vehicles moving on land and even pedestrians use modern satellite navigation systems. This satellite navigation system is called as Global Positioning System (GPS). GPS provides global coverage and better accuracy as compared to other navigation systems. GPS provides real time information of the user's location at any point on the surface of the earth provided that user has a GPS receiver.

In this paper a real time GPS receiver system is discussed. The system hardware consists of a GPS antenna, GPS receiver with a USB connector so that the receiver can be easily connected to a PC or laptop. The system software is developed in VB.NET computer programming language.

The GPS has been introduced in section 2. Section 3 provides details of related works. The system design has been discussed in section 4. The system execution methodology has been described in section 5. Section 6 explains the data format. Section 7 discusses the results obtained. Section 8 describes the conclusion and section 9 the acknowledgement.

II. GPS overview

NAVSTAR (Navigation Satellite Timing and Ranging) is a network of satellites that provides GPS services all over the planet. The GPS is controlled and maintained by the United States of America (U.S.A). GPS consists of three segments. They are space segment, control segment and user segment. The three segments of the GPS shown in the fig. 1

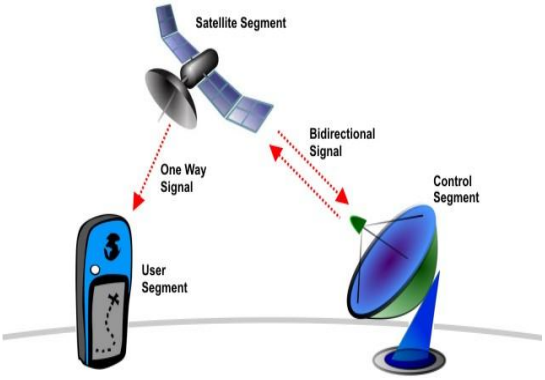

Fig. 1 shows the segments of GPS

2.1 The space segment

The space segment consists of a core constellation of 24 satellites. This constellation ensures that the GPS receiver can track at least 4 satellites from any point on the planet. The satellites fly in the MEO (Medium Earth Orbit) at an altitude of about 20,200 km from the surface of the earth. Presently the space segment consists of a 27 satellite constellation. The extra three satellites ensure increased coverage and improved accuracy of the GPS system. The satellite signal received by the GPS receiver consists of satellite orbital and clock information, information and status regarding all the satellites and an ionospheric model for error correction.

2.2 Control segment

The GPS control segment consists of global network of ground facilities that track the GPS satellites, monitor and analyze their transmission and send updated and corrected information to the satellites. The control segment mainly consist of a master control station, an alternate control station, four dedicated ground antennas and six dedicated control stations. The monitor stations track the satellites, and constantly receive the satellite data. This information is send to the master control station. The master control station uses this information to compute precise locations of the satellites in space and uploads this information to the satellites using the ground antennas.

2.3 User segment

The user segment is composed of numerous military and civilian GPS receivers. The GPS receiver may be held in hand or a can be mounted on the vehicle. The user segment processes the satellite signals and computes precise values of navigational and positioning parameters like latitude, longitude, altitude, speed, etc. The GPS receiver may include display for providing location information to the user.

III. Related works

Over the past few years, many researchers have designed and developed numerous applications using GPS navigation system in the fields like defense, transportation and space applications. Many applications where GPS has been used with other technologies like GSM, CDMA and internet to provide mobile navigation and on-line tracking have also been designed and developed. A complete GPS receiver design and its implementation using simulink graphical programming language is discussed in [2]. [3] Describes an advanced GPS signal processing architecture and illustrates that how it can be applied to extend the GPS coverage into difficult environments such as indoors, urban canyon and under dense urban canopies. A design of a software based GPS/Galileo receiver, including a structure of combined software GPS/Galileo receiver with multipath mitigation and Receiver Autonomous Integrity Monitoring (RAIM), which can utilize the publicly available GPS and Galileo signals is presented in [4]. A GPS-SBAS (Global Positioning System-Satellite Based Augmentation System) receiver which is developed using a Digital Signal Processor (DSP) and engineered for use in avionics applications is discussed in [5]. A discussion regarding the use of ASIC, FPGA and DSP technologies to design and develop future GNSS (Global Navigation Satellite System) receivers is given in [6]. A GPS receiver using a RF front end and Analog to Digital converter, and a software approach for acquisition, tracking and navigation is introduced in [7].

IV. System design

The GPS receiver system block diagram is shown in fig. 1. The system is composed of hardware module and software module.

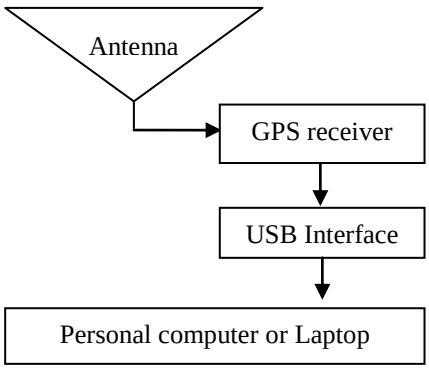

Fig. 2 shows GPS receiver system block diagram

The system hardware and system software are described as follows,

4.1 System hardware

The system hardware consists of GPS antenna, GPS interface and a PC or laptop.

4.1.1 GPS antenna

The GPS antenna receives the satellite signals. The signals are acquired by the GPS receiver by the antenna. The antenna used is an active antenna and receives power supply from the GPS receiver. The antenna is tuned to the frequency of 1575.42MHz which is the L1 (Link 1) frequency component of satellite signal. The L1 frequency component is available for civilian use.

4.1.2 GPS receiver

The satellite signals received by the antenna are acquired by the GPS receiver using the USB interface. The receiver processes the satellite signals and generated information strings in the NMEA-0183 (National Marine Electronics Association) protocol format. These information strings are available at the USB connector output. The receiver draws power supply from the PC or laptop. The receiver provides real time positioning and tracking parameters like latitude, longitude, speed, altitude, satellite information, course over ground and Horizontal Dilution of Precision (HDOP). This information is available in the NMEA-0183 protocol format such as GPGGA (Global Positioning Global Positioning system fixed data), GPGSA (Global positioning GPS DOP and Active Satellites), GPGSV (Global positioning GPS Satellite in View), GPGLL (Geographic Position in Geographic latitude/ longitude), GPRMC (Global Positioning Recommended minimum specific GNSS data), GPVTG (Course over ground and ground speed).

4.1.3 USB interface

The USB interface simply consists of a USB connector which is interfaced with the receiver and can be easily connected to a PC or laptop. The information strings from the receiver are given to the PC or laptop USB port using the USB interface.

4.1.4 PC or Laptop

The NMEA information strings from the receiver are acquired by the PC or laptop. These strings are processed by the system software and the positioning and tracking parameters are extracted. These extracted parameters are displayed on the GUI on the PC screen. The website table is continuously updated by the positioning and tracking parameters. On pressing the 'SEND MESSAGE' button on the GUI, a SMS containing the user's location, longitude, latitude, altitude, speed and location name is send to a particular mobile number. The minimum required configuration of a PC or laptop is 512 MB RAM (Random Access Memory), 40 GB hard disk, Pentium processor and a USB port.

4.2 System software

The system software processes the NMEA information strings and extracts the required parameter values. The software is programmed in VB.NET application oriented programming language. The extracted parameters values are then displayed in the textboxes in the GUI. The GUI on which the parameter values are displayed is named as 'GPS PARAMETERS'. A user login GUI is also designed and developed. This GUI is named as 'GPS SYSTEM LOGIN'. The user must enter correct username and password. Upon entering correct username and password the 'GPS PARAMETERS' GUI will be displayed. The 'GPS PARAMETERS' GUI is provided with an 'EXIT' button. On pressing this button the GUI application exits. The website application can be accessed by using any internet browser. The website is also provided with user login facility for security purpose. On starting the website application a window asking for correct user name and password appears. On entering the correct user name and password, next website page is displayed. This page displays the table containing the values of parameters like latitude, longitude, altitude (mean sea level), speed and location name. The software also comprises of a messaging application which sends an SMS to a particular mobile number. The 'GPS PAREMETERS' GU I consists of a 'SEND MESSAGE' button. On clicking this button an SMS containing the user's present location in terms of latitude, longitude, speed, altitude and location name is send to the mobile number. In order to send the SMS, the messaging application requires internet availability. The SMS is send using the online messaging services. The minimum required configuration of the PC or laptop, in order to execute the system software is Microsoft visual studio 2005/08/10, dot.net framework 2.0 and any internet browser. The designed software module is user friendly and easy to operate.

V. Data format

The system makes use of National Marine Electronics Association (NMEA) information strings. NMEA defines a communication standard for devices that include GPS receivers. The GPS receiver outputs geospatial location, time, headings, navigation related information and the GPS satellites information in the form of NMEA strings. Out of this the following GPRMC string format is used in this system,

*$GPRMC 161229, 3723.2475, 12158.3416, W, 0.13, 309.62, 120598,,*45*

GPRMC provides recommended specific GPS data.

VI. System execution methodology

The GPS receiver system execution flow is shown in the fig. 3. The flow chart presents the system working in detail. All the stages and the processes of the system from the stage of initialization till the output stage are described in detail.

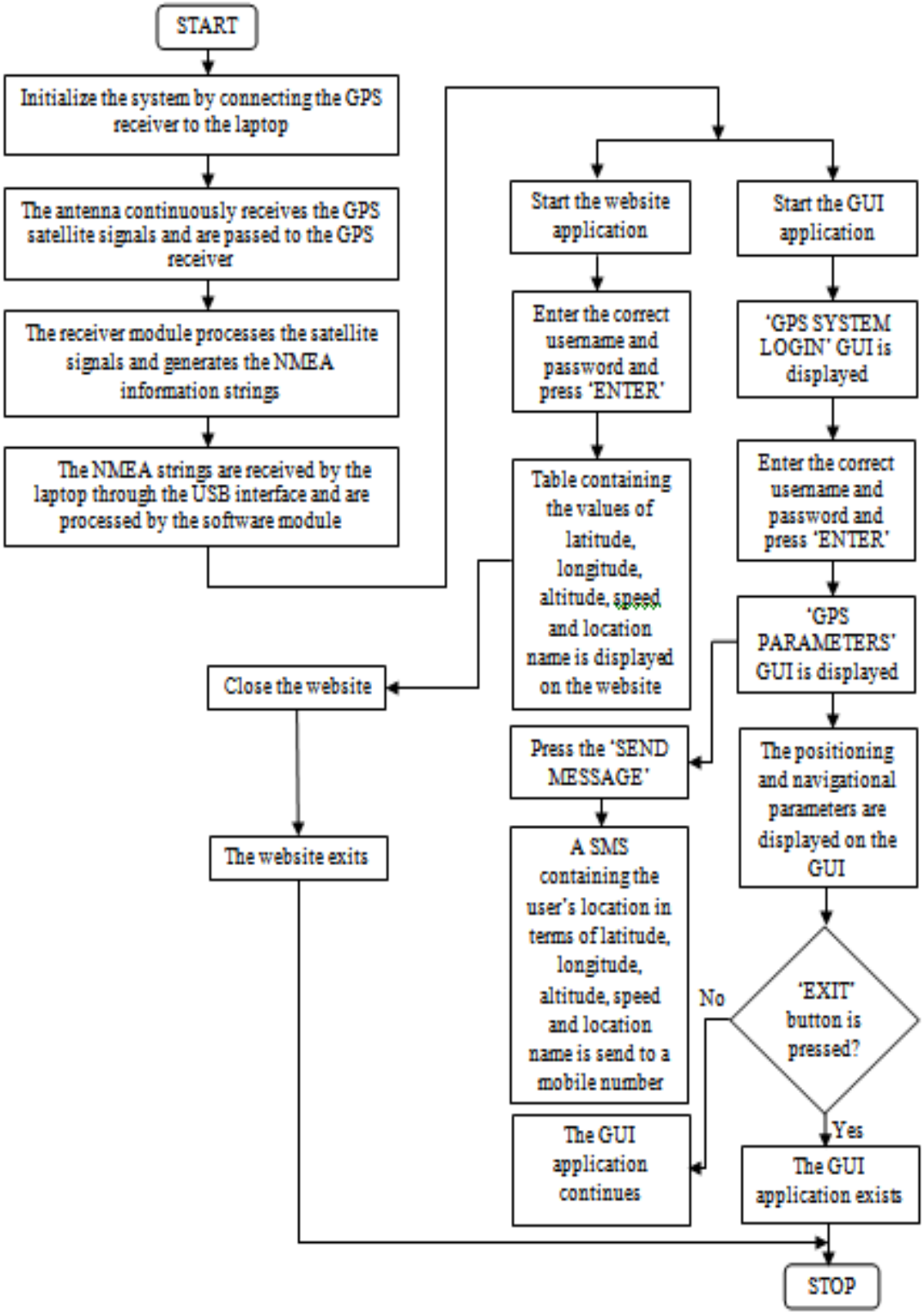

Fig. 3 shows the system execution flow sequence

VII. Results

To evaluate the performance of the system the results of the system were noted. The results of the system are tabulated and are presented in table 1 and table 2.

Table 1 shows the location based parameters of the GPS receiver system user like Latitude, Longitude and Altitude at certain locations

Sr. no.	Latitude (N)	Longitude (S)	Altitude (m)
1	2001.9827	07378.7393	620.5
2	2001.8876	07378.7396	620.8
3	2001.6145	07378.4064	621.4
4	2001.1254	07377.5020	622.8
5	2000.8902	07377.2241	621.3
6	2000.7145	07377.1345	622.7
7	2000.5021	07377.0624	623.1
8	1999.8155	07376.9186	623.0
9	1999.7990	07376.9192	622.4
10	1999.4638	07376.9234	621.8
11	1999.4324	07376.3094	620.7
12	1999.3750	07375.4035	620.4
13	1999.1245	07375.0268	620.7
14	1998.9842	07375.6424	620.7
15	1998.2476	07375.9534	620.3

The results in the table 1 are obtained from 'GPS PARAMETERS' GUI. The parameters like Latitude, longitude and Altitude of certain locations are tabulated and are shown in the table 1. Using the latitude and longitude values the location of the user at any point on the planet can be found. The altitude value is the altitude of the user above mean sea level. The parameter values in the table 1 are also displayed in the website in tabulated form.

Table 2 shows the speed and location names of the user for the same locations as in table 1

Sr. no.	Speed (km/hr)	Actual Point/Location name
1	5.42	A
2	5.26	B
3	5.34	C
4	6.5	D
5	6.43	E
6	7.57	F
7	8.12	G
8	8.46	H
9	7.58	I
10	6.42	J
11	6.54	K
12	7.58	L
13	3.25	M
14	4.26	N
15	6.44	O

The results in the table 2 are also displayed in 'GPS PARAMETERS' GUI. The speed and the location names of the user's position are for same locations for which the values of the location based parameters are given in table 1. The speed and the location names are also displayed in the website table along with the other parameters. For brevity the location names are written in symbolic form.

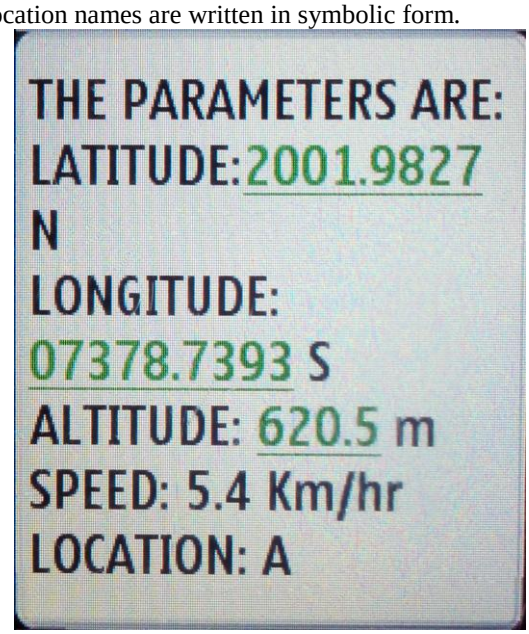

Fig. 3 shows the message received by the user on using the SMS service

On pressing the 'SEND MESSAGE' button on the 'GPS PARAMETERS' GUI a message describing the positioning and navigation data of the user in terms of latitude, longitude, altitude, speed and location name is send to a particular mobile number. The message received by the user at location point 'A' is shown in the figure. For brevity the location name is represented as an English alphabet.

VIII. Conclusions

A real-time GPS receiver system is designed and developed successfully. The system provides real-time positioning and navigation information. All the applications like GUI application, website application and the SMS service run successfully and the desired results are obtained. The developed system is low cost, compact, small in size and reliable. The results obtained from the system are shown in the paper in the form of tables and figures. The system can be used for on-line tracking by superimposing the results of the system on a GIS (Geographic Information Systems) system. The system provides global coverage and can be used anywhere on the planet.

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